Telemaintenance as a Process to Increase Maintenance Effectiveness and Efficiency

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"Telemaintenance can make a 'B' maintainer into an 'A' maintainer."

U.S. Army Communications-Electronics Command (CECOM)[1]

Telemaintenance is a term used to describe the electronic transfer of data or information between a maintainer and another individual or source to apply more expertise during a maintenance task. Encouraged by the explosive growth in communications technology that has resulted in a wide range of "tele-support" applications in the commercial sector, the military services are exploring where and how telemaintenance can provide timely and accurate information for maintenance assessments and decisions. Appropriately applied, telemaintenance can improve the effectiveness and efficiency of maintenance resources.

The potential advantages of telemaintenance are numerous and include

- avoiding delays in the maintenance process,
- ensuring accuracy of failure data,
- delivering greater technical expertise to the work site, and
- facilitating repairs at the lowest appropriate maintenance level.

The purpose of this report is to provide an overview of Department of Defense (DoD) telemaintenance. The DoD's interest in telemaintenance results from a

[1] U.S. Army, Communications-Electronics Command (CECOM), Logistics and Readiness Center, *Telemaintenance,* briefing presented at the Telemaintenance Integrated Product Team meeting, June 15-16, 1999.

growing need to increase equipment readiness, reduce logistics "footprints" (size and cost), and improve maintenance responsiveness.

The military services have applied the term "telemaintenance" to a variety of efforts. In this report, we describe initiatives that focus on the transfer of information *electronically* between the maintainer and *remote* resources to perform a maintenance action. Additionally, we highlight only efforts that are operational. Finally, telemaintenance, in the context of this report, does not include technologies that inform the maintainer of the condition of an item through built-in-test capabilities or portable maintenance diagnostic techniques. Telemaintenance also does not include computers without remote connectivity, although these computers may provide access to built-in technical data or interactive electronic technical manuals (IETMs). Structured distance learning initiatives are also excluded.

To describe features of current telemaintenance capabilities in the DoD maintenance community, we identify

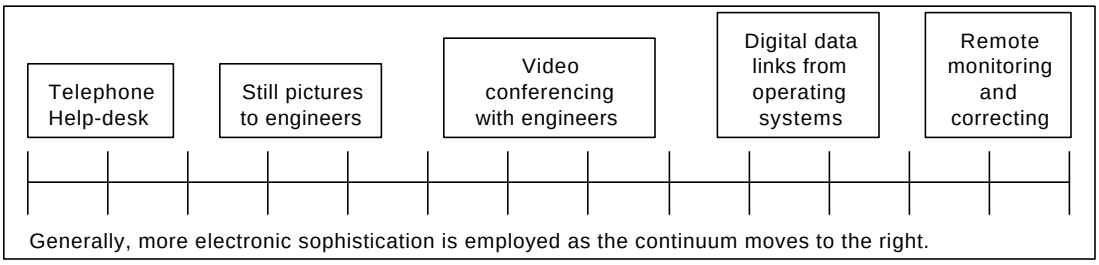
- a range of telemaintenance technological approaches,
- representative programs and initiatives, and
- telemaintenance imperatives.

TELEMAINTENANCE TECHNOLOGICAL APPROACHES

Telemaintenance initiatives can be for a platform, weapon system, or component. Initiatives can also be created for a maintenance process (e.g., troubleshooting assistance through help desks) and applied across a wide range of equipment. These alternative approaches tend to obscure any common baseline and create "pockets of technology" within and across the military services.

Telemaintenance can be viewed as a capability from two perspectives. First and more commonly, it can be external equipment, such as a phone, a computer workstation, or a portable video camera with communications (e.g., Internet) capability that can be used throughout an organization. Second, the capability can be internally installed (such as in a satellite, engine, or component) to sense and report performance, wear, or other data, providing feedback and possibly even applying corrective adjustments remotely. Across this wide range of technological sophistication, telemaintenance fulfills its primary goals of improving the information available to the maintainer about a malfunction or maintenance requirement—and bringing additional expertise online in a timely and responsive manner. Figure 1 depicts examples of telemaintenance approaches along a continuum.

Figure 1. Telemaintenance Continuum



Several electronic approaches to enhance maintenance capabilities were implemented long before the term "telemaintenance" was coined. For decades, organizational and intermediate level technicians have explored maintenance issues and obtained technical information and guidance from depot engineers and original equipment manufacturer (OEM) representatives by telephone or facsimile. Almost all telemaintenance actions have been made to respond to an unscheduled or isolated event, when routine maintenance failed to complete a repair or damage exceeded normal limits. Significant advancements in equipment and communications technologies that support telemaintenance concepts have continued to provide better and faster capabilities to capture, pass, and share information. These capabilities, in turn, enable the military services to replace their current maintenance infrastructure with telemaintenance capabilities or to attempt—with telemaintenance support—more complex or sophisticated repairs in the field. The rapid growth of communications technology offers the potential to improve telemaintenance capabilities even further.

SERVICE TELEMAINTENANCE PROGRAMS AND INITIATIVES

The military services have several significant telemaintenance initiatives. Because the services have only recently pursued service-wide or joint approaches, they may be planning or implementing other initiatives that incorporate telemaintenance features that we did not identify. For example, although the Air Force did not identify any established program, it provided an example of using telemaintenance when the rear cargo door of a C-5 had a damaged cargo door hinge. A crew member took several pictures of the hinge with a digital camera, sent them electronically to engineers at the Warner Robins Air Logistics Center, and received clearance for continued flight after their review. Immediate benefits included increased strategic lift capability and avoidance of unnecessary maintenance costs.[2]

[2] Interview of Colonel G. Locklear, HQ USAF/ILMM, by D. Cutter and A. Timko, Logistics Management Institute, November 8, 1999.

Army

The Army has formed a Telemaintenance Integrated Product Team (IPT), led by CECOM, to identify and develop prototype candidates, refine telemaintenance concepts, and solicit financial resources. The IPT consists of representatives from major commands, including the Army Materiel Command (AMC) and its major subordinate commands, program executive officers (PEOs) and program managers, and the Combined Arms Support Command.

The Army's IPT is built on two concepts: Projecting National Maintenance Expertise Forward and Maintainers On Line. Similar to telemedicine methods, Army telemaintenance approaches seek to leverage AMC's intellectual capital (e.g., depots, logistics assistance representatives [LARs], logistics centers of excellence, OEMs, and maintenance engineers) through data communications and collaboration with maintainers in the forward area. Maintenance shops at all levels will be able to collaborate with each other and subject matter experts (SMEs) by using data, video, and voice communications.[3]

Building on the tenets of the IPT, the Army Aviation and Missile Command (AMCOM) has established an objective for telemaintenance to enhance maintenance capabilities at all levels by integrating prognostics, video conferencing, data compression, and other enabling technologies. AMCOM identified approximately $13 million in funding between FY99 and FY03 to accomplish requirements definition, development, integration, user test and evaluation, engineering change proposal requirements, kit production, and deployment. AMCOM's telemaintenance "exit criteria" are depicted in Table 1.[4]

In the communications and electronics (CE) areas, the Joint Commanders Group for Communications and Electronics coordinates military CE programs and includes telemaintenance as one of its panels. Its objectives are to exploit telemaintenance concepts and technologies to reduce operations and support costs, leverage commercial technologies and products, share experiences, and seek opportunities to reduce duplication and enhance interoperability.[5]

[3] CECOM (R. J. Potter), *AMC Telemaintenance Initiative Developed by CECOM*, memorandum, November 29, 1999.

[4] AMCOM, *Telemaintenance*, briefing presented at the Telemaintenance Integrated Product Team meeting, June 15–16, 1999.

[5] Joint Commanders Group for Communications and Electronics, draft briefing to the Military Communications-Electronic Board, February 28, 2000.

Table 1. AMCOM Telemaintenance Exit Criteria

Operational capability	Baseline	Minimum	Goal
Increase readiness	Current readiness rate	Maintain current readiness	Achieve measurable improvement on all weapon systems
Reduce operations and support cost	Current budget projection	Reduce cost 10%	Reduce cost 25%
Provide timely and accurate situational awareness	Manual inspection; messages handled through existing communications	Transmit source data near real time from platform to company level for roll up	Transmit to forward support battalion CSSCS in near real time
Use existing communications network	Logistics communications requires additional systems	Automate remote, source data at unit level	Provide remote, source data and automated process, integrated to Combat Service Support (CSS) Control System and CSS Standard Army Management Information System
Integrate with asset visibility initiatives	Limited linkage to asset visibility systems	Interface data to use with Total Asset Visibility (TAV)	Integrate through Logistics Anchor Desk into automated supply systems (TAV, Global Combat Support System)

The following two initiatives are illustrative of the Army's telemaintenance efforts:

- The Collaborative Communications Technology project establishes a system for real-time, wireless access between a soldier in the field and SMEs, OEMs, depots, and LARs. The key hardware element is a wearable computer, referred to as a "tool belt," that provides test equipment, records, manuals, and parts inventories with expertise for troubleshooting, repair, and training. Connecting links operate through wireless local and wide area networks of commercial or tactical telephones, radios, or satellites. Video conferencing, a chat room with white board and the 1553 data bus interface, can be used for projecting technical expertise forward. While just beginning with a few wearable and multiple desktop versions fielded, this capability represents a broad application of an Army telemaintenance concept with efforts at
  - Fort Huachuca for a strategic satellite system,
  - Fort Hood for Abrams tanks, and
  - Tobyhanna Army Depot that supports LARs outside CONUS.
- The Air and Missile Defense PEO has developed the Patriot Integrated Diagnostics Support System. By using multiple connection links, the system provides more capability at the point of repair by enabling access to

remotely located system experts. Depot expertise from Red River Army Depot and other SME are linked by satellite to Patriot maintenance facilities in Germany and Korea. This initiative has been operational since 1996.

Navy

Under a unified Distance Support plan, Naval Sea Systems Command (NAVSEA) and Naval Supply Systems Command (NAVSUP) have combined initiatives with themes of reducing shipboard workload and streamlining fleet support processes and infrastructure access. The Anchor Desk is a phased implementation focused on creating the appropriate infrastructure to move some functions, including equipment monitoring and maintenance, ashore or reduce workload afloat.[6] The Anchor Desk includes the following initiatives:

- The Integrated Call Center (ICC) in Norfolk offers the fleet "one-touch" telephone service for technical and logistics support. Questions not handled directly at the ICC are routed to NAVSUP, the Fleet Technical Support Centers, and referral agencies. The ICC also acts as a front page for the Naval Space and Warfare Command's and Naval Air Systems Command's (NAVAIR's) help desks and Web sites, which are alternate routes to a weapon system point of contact.

- Telogistics started as a demonstration project by the Deputy Under Secretary of Defense (Logistics) with the mine warfare community. Hardware and software for full 2-way audio and video conferencing were installed on the USS Scout (MCM-8) and ashore at Shore Intermediate Maintenance Activity Ingleside and Naval Coastal System Station Panama City that support the SLQ-48 and SQQ-32 weapon systems. In addition to telemaintenance, the objective is to demonstrate the relationship and synergistic effect of integrating diagnostics, digitized technical data, and distance learning on weapon system operational readiness and life-cycle cost.[7] Future phases will add major ship systems, provide integration into NAVSEA's information technology (IT) architecture, and extend the solution to other weapon systems on other MCM platforms.

- The Commander in Chief, Pacific Fleet, tasked Naval Surface Warfare Center (NSWC) Crane and Commander, Naval Air Pacific, to develop and field hardware and software to link the ship to shore sites via network operating centers. The video telemaintenance (VTM) goal was to replace technical assistance visits for responding to equipment casualties with an interactive commercial-off-the-shelf (COTS) capability that uses the IT installations already on board. The portable tool kit includes video and still

[6] Draft Distance Support Anchor Desk Plan, June 14, 1999; available at http://www.fleetsupport.navy.mil/index.htm, accessed December 17, 1999.

[7] Larry Hanagan, Dell Computer Corporation, *The Telogistics Solution in Process Review*, August 5, 1999.

cameras and a portable personal computer with a built-in multimeter and oscilloscope. Three carriers have been outfitted, and a full battle group is being prepared. Initially, the most used features are the whiteboard and chat room that have a real-time video capability.

- Sailor-to-Engineer is an initiative from NSWC Port Hueneme to support combat systems as part of its in-service engineering activity responsibility. It includes a Web site, email service, action tracking, and video conferencing features. It leverages existing fleet IT capabilities. NSWC Port Hueneme recently teamed with NSWC Carderock (Detachment Philadelphia) to act as the Web site for hull, mechanical, and electrical systems. Discussions are underway to link with VTM from NSWC Crane.

- Integrated Condition Assessment System monitors propulsion plant, electrical, and ancillary systems with remote sensors; reports through a local area network; and initiates condition-based maintenance actions (a few of which may be remote adjustments). The system is installed on more than 60 ships. Additional installations as well as expansion into the SPS-49 combat system are planned.

NAVAIR is the lead for a Joint Aviation Commanders Group pilot project, the Joint Aviation Technical Data Integration (JATDI). JATDI is a set of initiatives to create an integrated data environment where data, training, and maintenance expertise flow seamlessly. It has a broad charter to collaborate throughout DoD and leverage existing programs for common solutions. The objective is to provide engineering, logistics, and maintenance data and expertise to mechanics on the flightline by a cheaper and faster means.[8]

- TECH CAM is a telemaintenance effort of JATDI. As a two-way Web-based audiovisual system, it links the remote maintainer with engineering support personnel ashore. This effort provides video teleconferencing at a desktop but requires installation of Integrated Services Digital Network lines. Selected shore H-60 and EA-6B squadrons in the Navy and Marine Corps are equipped to collect data for fleet testing in the summer of 2000. Additional Marine Corps, Army, and Air Force sites are being considered as well as teaming with the VTM effort of NSWC Crane.

- A similar effort in testing with the FA-18E/F program is the Help Request Document system. The system is a Web-based, modified COTS product that features linkages for aircraft damage repair and eliminates the need to dispatch engineering experts to the field. The system also includes capabilities for processing electronic technical manual deficiencies.

[8] NAVAIR, *JATDI—Brief for N88*, briefing, September 28, 1999.

Air Force

Although the Air Force has not established a single telemaintenance lead, it does support a variety of initiatives. Its help desk concept has been a part of the Air Logistics Centers for a long time and provides a command liaison for field maintainers to contact for depot technical assistance. Various initiatives have proven beneficial during prototype, such as video connectivity in performing aircraft damage assessment and repair triage from the field and pen-based portable computers with video in the depots.

The F-22 aircraft Integrated Maintenance Information System is a platform-unique, paperless system in flight test with the Raptor. The system is scheduled to be fielded with the aircraft in 2002. With a Class 5 IETM and an active interface with the aircraft systems for ground testing, it will provide a planeside radio frequency link to a local server for maintenance documentation, supply requisitions, and technical assistance. It will electronically pass through the Air Force's standard information system, the Integrated Data Management System, to gain the functionality of existing support systems. Remote field operations will be achieved through mobile servers and transmitted to a global server.

IMPERATIVES FOR TELEMAINTENANCE

Each military service is expanding its telemaintenance initiatives, although resources are limited. In general, the approaches are often decentralized, specifically focused (i.e., on a single system), and not generally institutionalized. They are often single commodity or platform class applications, reflecting a programmatic approach. Indeed, many initiatives are led by a program or system manager. Further, dialogue among the military services that could contribute to broader acceptance and implementation of telemaintenance concepts has been limited. We did not observe any change to maintenance infrastructure or operational policies because of the expanding telemaintenance capabilities. However, emerging technological enhancements can have a clear effect on the speed and footprint aspects of maintenance support.

The success of a telemaintenance initiative often depends on equipment and facility factors, such as equipment modernization or facility outfitting, and on associated technological factors, such as communications bandwidth, data configuration, or computer resources. Implementation is facilitated by design features found only in recently acquired systems (i.e., new weapon systems). Consequently, telemaintenance capabilities have yet to be fully exploited because of massive legacy equipment challenges. Telemaintenance is still basically supplemental in nature and used in unique applications rather than being a pervasive practice and routine means of providing expanded maintenance information.

The motivation for pursuing telemaintenance initiatives is often associated with operational concepts for a weapon system or equipment. The more isolated and

detached from the support infrastructure an operational element becomes, the greater the potential benefit to be derived from telemaintenance applications.

CONCLUSIONS AND RECOMMENDATIONS

We found several substantive DoD telemaintenance initiatives to enhance support to the maintainer. Many initiatives are facilitated by new, improved telecommunications capabilities. But, it is too early to predict the long-term, institutional role of telemaintenance in DoD because the focus of many initiatives is within one military service and frequently at a system level. DoD should, however, be concerned about leveraging lessons learned to support appropriate expansion telemaintenance concepts and approaches.

Therefore, we recommend that the Assistant Deputy Under Secretary of Defense (Logistics) for Maintenance Policy, Programs, and Resources (ADUSD[L]/MPP&R) consider promulgating policy that

- defines telemaintenance,
- identifies the potential of telemaintenance concepts,
- expresses support for initiatives and new applications as well as for expanding current approaches,
- calls for the military services to share relevant information, and
- requires that the military services designate a single focal point for their telemaintenance efforts.

Additionally, we recommend that the ADUSD(L)/MPP&R conduct periodic forums with the military services and commercial industry to explore telemaintenance concepts and applications and to encourage further appropriate expansion.